DOCUMENT RESUME

ED 372 877 RC 019 282

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TITLE	Minority Engineering Programs: A Case for Institutional Support.
INSTITUTION	National Action Council for Minorities in Engineering, Inc., New York, NY.
SPONS AGENCY	AT&T Foundation, New York, NY.
PUB DATE	May 93
NOTE	13p.
PUB TYPE	Collected Works - Serials (022)
JOURNAL CIT	NACME Research Newsletter; v4 n1 May 1993
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Persistence; American Indians; Blacks; *College Programs; *Engineering Education; Enrollment; *Financial Support; Higher Education; Hispanic Americans; *Minority Groups; Secondary Education; *Student Attrition; Student Recruitment
IDENTIFIERS	*Minority Engineering Programs; Student Support Services

ABSTRACT

Minority engineering programs (MEPs) were established in the late 1970s to recruit minority students to engineering education and reduce their dropout rate. MEPs at 20 engineering schools were examined in relation to institutional environment; pre-enrollment activities; and services that encourage community building, provide academic support, and enhance students' personal and professional development. Data from interviews with program staff, faculty members, university staff, and current and former students were analyzed. Eight of the 20 universities were identified as being the most successful in recruiting and graduating minority students. MEPs at these universities tended to recruit the best qualified students directly from high schools, establish summer programs that stress study and critical thinking skills, provide study centers, have sufficient supplies of tutors available to intervene when students had academic problems, and have higher levels of university funding when compared to other programs. Although enrollment figures for minority students in engineering programs have increased, the attrition gap between minority and nonminority students remains. Recommendations largely target universities and include the need for increasing institutional support for MEPs, increasing student financial aid, increasing the number of minority engineering faculty, addressing diversity issues, and initiating longitudinal studies to better understand MEP participants and dropouts. Includes data tables and figures. (LP)

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NACME

May 1993 Volume 4 Number 1

Research Letter

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ED 372 877

Minority Engineering Programs

A Case For Institutional Support

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Catherine Morrison and Lea E. Williams

Undergraduate engineering degrees awarded to African Americans, Hispanics and American Indians more than tripled in the nineteen year period from 1972-73 (1,255) to 1991-92 (4,681)[1]. Much of this increase can be attributed to efforts initiated in the early seventies when foundations, corporations and schools of engineering launched a national movement to expand the participation of underrepresented minorities. For example, the NACME organization was established, ethnic-specific organizations were formed and precollege programs were developed.

While enrollment has been robust, minority students' persistence lags far behind their nonminority peers. In analyzing national enrollment and graduation data for the 1980's, NACME found that only 35.6 percent of minority engineering freshmen obtained a BSE (bachelor of science in engineering) degree compared to 68.4 percent of nonminorities[2]. Among those who persist into the sophomore year, only 56.7 percent of minority students graduate compared to 87.4 percent of nonminority sophomores. In other words, a minority freshman's relative graduation rate is about half (52 percent) that of a nonminority student. When this student achieves sophomore status, the graduation rate of minorities relative to nonminorities improves to 64.9 percent.

Minority engineering programs (MEPs) have attempted to intervene in the devasting cycle of minority student attrition. These retention efforts, established in the late 70s and

This report is based on a study by the Educational Testing Service (B.C. Clewell, et al), commissioned by NACME and made possible by a grant from the AT&T Foundation. Catherine Morrison is director of research and Lea E. Williams, Ed.D., is executive vice president of the National Action Council for Minorities in Engineering (NACME).

RC 019282

Highlights

- Almost unanimously, deans laud MEPs as beneficial to engineering schools' efforts to increase minority participation, yet programs often lack adequate institutional funding for salaries and basic operating costs. On average, institutions with high retention provide 78 percent of funding for their MEPs. By comparison, institutions with low retention provide only 32 percent of the MEP budget. Only four out of 20 MEPs in the study received full support from their institutions.
- Although faculty participate in a wide range of outside activities, MEP directors note a lack of substantive faculty involvement in activities that affect minority students' academic success.
- The lack of institutional support and faculty involvement cause MEPs to remain isolated and outside the mainstream of engineering schools in much the same way as the underrepresented students they serve.
- Few universities systematically collect and analyze longitudinal data on persistence and graduation. Generally, MEPs maintain a database on current students (test scores, high school grades, course enrollment, grade point averages), but longitudinal data would help them secure institutional support.
- While most of the components of the NACME/NAMEPA MEP model were found across all programs studied, in the absence of longitudinal data their presence could not be correlated justifiably with the retention levels of the schools in which they were located.
- Most MEPs that do recruitment, recruit high-achieving middle and high school students, placing less emphasis on at-risk students who have expressed an interest in science, as well as students in two-year institutions.
- The importance of summer bridge programs in strengthening students' academic skills and providing an orientation to college life is widely recognized among the MEP staff, engineering school administrators, faculty and students.
- MEP directors work with engineering school deans to ensure that minority applicants are evaluated fairly and equitably, using multi-dimensional criteria. But as a group, MEP directors have little power to influence the admissions policies that universities have developed for minority engineering applicants.
- University efforts to improve retention tend to focus exclusively on students. This approach does not directly address institutional obstacles, cross-cultural communications barriers, low faculty expectations, etc.—factors that contribute to the high attrition of minority students. As a result, even if an MEP program is effective, because it deals largely with students, it does not bring about permanent change in the institutional environment.

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throughout the 80s, were designed to help recruit minority students, assist them in negotiating the engineering school environment and, ultimately, reduce the number of students of color dropping out of engineering before completing their degrees. Since MEPs came into existence the enrollment of minority students has improved substantially (Tables 1 & 2), but attrition has remained unacceptably high.

Introduction

In shaping its agenda for the 90s, NACME commissioned the Educational Testing Service (ETS) to conduct a study of minority engineering programs at twenty engineering schools across the nation. The study sought to determine the extent to which the conceptual model of a minority engineering program actually exists and to define the kinds of efforts and activities unique to MEPs at institutions with the highest minority persistence and graduation rates.[3]

Looking ahead, NACME used this study to formulate recommendations for strengthening programs, to call attention to the need for institutional change, and to identify areas of needed research.

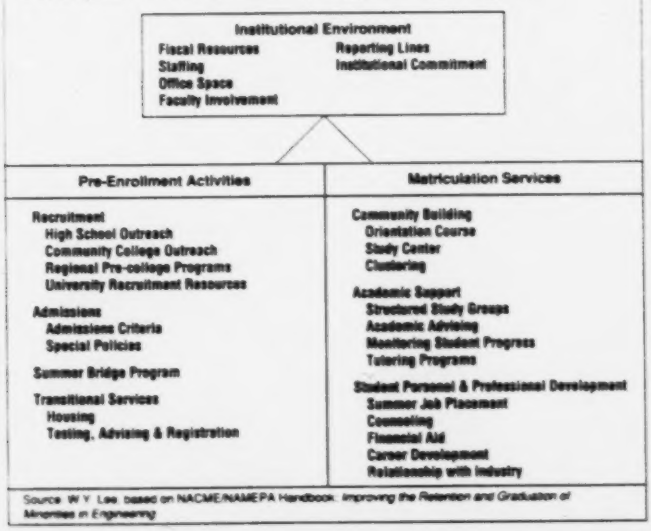
Table 1.
Fall Semester Freshman Enrollments* In Engineering

Academic Year	African American	Hispanic American	American Indian	Total Minority	Total Freshmen	Percent Minority
1973-74	1,684	525	40	2,249	51,207	4.4%
1974-75	2,447	888	89	3,424	62,582	5.5%
1975-76	3,840	1,384	120	5,344	74,558	7.2%
1976-77	4,372	1,766	171	6,309	81,652	7.7%
1977-78	4,728	2,161	244	7,133	88,256	8.1%
1978-79	5,493	2,664	225	8,382	95,171	8.8%
1979-80	6,339	3,136	317	9,792	103,090	9.5%
1980-81	6,661	3,373	365	10,399	109,314	9.5%
1981-82	7,015	3,689	412	11,116	114,201	9.7%
1982-83	6,715	3,635	371	10,721	114,517	9.4%
1983-84	6,342	3,885	376	10,603	108,763	9.7%
1984-85	6,245	3,939	410	10,594	104,374	10.2%
1985-86	6,374	3,849	365	10,588	102,285	10.4%
1986-87	5,873	3,359	353	9,585	98,298	9.8%
1987-88	6,145	3,826	354	10,325	94,814	10.9%
1988-89	7,075	4,246	433	11,754	97,379	12.1%
1989-90	7,284	4,599	424	12,307	94,791	13.0%
1990-91	8,370	5,382	526	14,278	93,705	15.2%
1991-92	8,305	5,266	582	14,153	92,308	15.3%
1992-93	8,924	5,624	633	15,181	92,699	16.4%

Source: NACME
*Note: Figures do not include the University of Puerto Rico.

During the 1989-90 academic year, we identified 89 MEPs and selected 30 representative programs to be considered for site visits. For each institution, we compiled persistence and graduation data and categorized universities based on this quantitative information. The data came from NACME's exten-

Figure 1
Conceptual Model of Minority Engineering Programs



Source: W.Y. Lee, based on NACME/NAMEPA Handbook, *Improving the Retention and Graduation of Minorities in Engineering*

Figure 2.
High School Outreach Functions

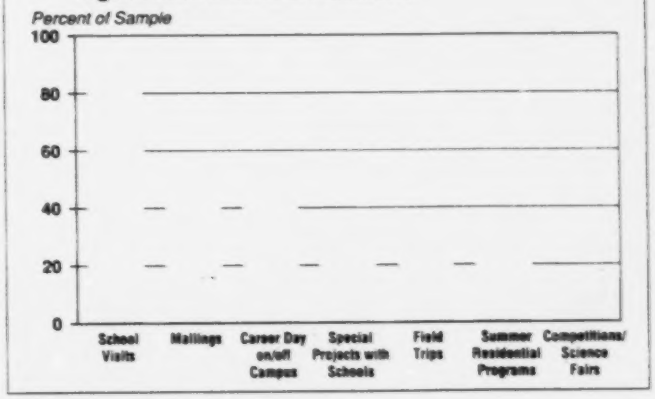


Table 2.

Fall Semester Undergraduate Enrollments* In Engineering

Academic Year	African American	Hispanic American	American Indian	Total Minority	Total Enrollment	Percent Minority
1973-74	4,869	2,371	204	7,444	183,520	4.1%
1974-75	6,319	3,158	360	9,837	197,899	5.0%
1975-76	8,258	3,941	317	12,516	228,183	5.5%
1976-77	9,828	5,138	446	15,412	254,797	6.0%
1977-78	11,388	5,944	618	17,950	286,500	6.3%
1978-79	12,954	7,158	625	20,737	308,556	6.7%
1979-80	14,786	8,454	759	23,999	337,807	7.1%
1980-81	16,181	9,043	903	26,127	362,300	7.2%
1981-82	17,611	10,200	970	28,781	384,162	7.5%
1982-83	17,598	10,683	1,078	29,359	400,038	7.3%
1983-84	17,817	11,599	1,127	30,543	402,561	7.6%
1984-85	17,451	12,202	1,186	30,839	391,052	7.9%
1985-86	17,994	12,941	1,120	32,055	379,830	8.4%
1986-87	16,830	11,913	1,071	29,814	365,161	8.2%
1987-88	17,300	12,981	1,136	31,417	352,848	8.9%
1988-89	18,227	13,188	1,164	32,579	342,280	9.5%
1989-90	18,939	13,761	1,205	33,905	334,723	10.1%
1990-91	20,909	15,917	1,468	38,294	335,102	11.4%
1991-92	21,891	16,374	1,538	39,803	335,585	11.9%
1992-93	23,136	18,088	1,809	43,033	340,271	12.6%

Source: NACME
*Note: Figures do not include the University of Puerto Rico.

sive Incentive Grants Program (IGP) database which contains retention, persistence and graduation statistics for more than 150 engineering schools that have been awarded scholarship funds since 1975. Each of the institutions referred to ETS was rated and ranked using four years of persistence data (1986-87 through 1989-90) and five years of graduation data (1980-81 through 1984-85). Based on our findings, institutions were divided into three categories of performance, each containing approximately one third of the total group of 89 MEPs. ETS then selected a representative group of 20 schools, using NACME's quantitative criteria as well as descriptive data such as geographic location, type of administrative control, age of the MEP, and program services offered. For the final group of 20 institutions:

- 16 were public institutions and four private;
- three were located in the Northeast, two in the Southeast, and five each in the Midwest, Southwest and West.
- total engineering enrollments ranged from 539 to 6,268 (mean = 2,652);
- total underrepresented minority enrollments went from 70 to 1,329 (mean = 334); and
- MEPs had been in operation from four to 16 years (mean = 10).

ETS developed a protocol based on the components in the NACME/NAMEPA MEP model. This protocol was used at each site to collect archival and interview data. Those interviewed at the sample sites included: program directors, their supervisors, program staff, two faculty members, and directors of university offices such as admissions and financial aid. In addition, current (freshman/ sophomore) and former (junior/senior) program participants were interviewed.

Nature and Prevalence of MEP Components

The typical minority engineering program, operating with minimal staff and limited institutional funding, offers a wide range of support services to students in the first two years of enrollment.

The theoretical MEP model (Figure 1) includes pre-enrollment activities (recruitment, admissions, summer bridge programs and transitional services), matriculation services (community building, academic support, student personal/professional development), and a set of characteristics that define the institutional environment in which the programs function (institutional commitment, fiscal resources, staffing, office space, faculty involvement and reporting lines). The components of the model are italicized in the discussion below.

Pre-Enrollment Activities

Generally, MEPs recruit through high school outreach, community college outreach and regional precollege program collaborations, as well as by using university recruitment resources (Table 3).

High school outreach consists of a variety of activities such as career days, science fairs/competitions, field trips to engineering facilities, summer residential programs for high school students, mailings of printed materials, school visits, and special projects that link MEP students and high school students (Figure 2). These activities are not always implemented by MEPs directly. Some do outreach through other university offices, such as the Office of Recruitment and Admissions. Some collaborate with regional precollege engineering programs. Most MEPs target high-achieving middle and high school students; less than half target students who are described as "at-risk," but who nonetheless have expressed interest in science and math (Table 4).

Community college outreach occurs less often than high school outreach. Only half of the programs (n=10) conduct community college outreach

Table 3.
Recruitment and Admissions Functions

Recruitment	Percent of Sample
High School Outreach	100
University Recruitment Resources	85
Relationship with Regional Precollege Programs	85
Community College Outreach	50
Admissions	
Standard Institutional Admissions Requirements	40
Standard Policies/Some Flexibility	30
Special Policies for Minority Applications	65

Table 4.
High School Outreach Target Populations

School	Percent of Sample
High School	80
Middle School	45
Students	
High Achieving	65
At Risk but Interested in Math/Science	30
Science Club Members	15

activities, compared to 80 percent that recruit high school students. However, many MEPs (n=14) participate in some type of articulation agreement with community colleges.

MEP staff work with *regional precollege programs* by making school visits and bringing precollege program participants onto campus for activities such as science fairs and contests, Saturday academies, summer programs and campus tours. MEP students and minority engineering student organizations often collaborate with precollege programs by sponsoring workshops, tutoring sessions and career days. Success is mixed: While some MEPs successfully recruit from these programs, other MEPs report that the students they contact enroll at institutions with more prestigious engineering programs or that offer better financial aid.

MEPs use *university recruiting resources* in a variety of ways (Figure 3). While a few programs (n=3) rely only on direct recruiting, most MEPS (n=15) combine their own recruitment efforts with those of the university by participating in joint recruiting trips and career day events, and follow-up on referrals of potential students.

Admissions criteria vary considerably among engineering schools, but most MEPs (n=13) apply special admission policies for minority applicants who do not fully meet standard requirements (Table 3). Usually, the College of Engineering requires applicants to have high school credits in specific math and science courses. To ensure that recruited students are admitted, most programs (n=14) actually oversee the admissions process. However, few MEPs (n=6) track students who do not enroll.

While MEPs have little influence on overall university *admissions policies*, most (n=13) have worked with the engineering school dean to ensure that minority applicants are evaluated fairly and equitably, using multi-dimensional criteria.

Sixty-five percent of the MEPs (n=13) offer *summer bridge programs* largely aimed at students needing additional academic preparation. These programs offer content courses in mathematics and science, enhance critical thinking and study skills, and provide a good orientation to the university. MEP staff usually send program materials to all minority students and encourage them to apply, especially those with weaker academic backgrounds. Students most in need academically are given preference for program enrollment. Attendance varies from only 10 percent of the minority enrollment to nearly all. Summer bridge programs are not necessarily remediation efforts; when the programs are perceived to focus on remediation rather than enrichment, minority students are inappropriately stigmatized. Minority students in engineering schools are, on average, as well-prepared academically as majority students.

MEPs offer a range of *transitional services*. Half of the MEPs (n=10) guide students to appropriate placement tests (Figure 4). Other assistance includes financial aid, helping students register for tests, reminding them of deadlines, administering diagnostic or placement tests and advising on course selection. The advising function seems to be effective since faculty indicate that MEP students are well-placed in their classes. Regarding financial aid, nearly all MEPs work with the financial aid office to try to obtain adequate funding for students. In addition, thirteen of the twenty MEPs studied indicated they administer some form of scholarship.

Matriculation Services

Matriculation services foster community building, provide academic support and enhance students' personal and professional development. All programs participate in these activities on some level.

Community building activities help to create a subculture and sense of camaraderie among MEP students within the school of engineering. Efforts to foster community building include freshman orientation, creating a student study center, clustering students in course sections and encouraging participation in student organizations (Table 5).

Nineteen of the programs studied offer formal *freshman orientation* courses to help students understand the expectations of the engineering school as well as the requirements for graduation. Over half of the MEPs (n=11) design their own courses; in other cases, it is a uni-

versity function. At nine institutions (45 percent) orientation is mandatory for students and carries academic credit. Most orientation programs (n=16) provide sessions on study skills, including time management and note-taking. Career awareness is another prevalent feature of orientation programs (n=14). Directors and students concur that these sessions are helpful. In addition to formal courses, some MEPs provide such orientation services as pairing freshmen with upperclass students, introducing students to department chairs or convening informal meetings and mixers throughout the year.

Eighty percent of the MEPs (n=16) have *study centers*. Most are located in an engineering building; other locations include a residence hall and temporary housing on the edge of campus. On two campuses minority engineering student organizations sponsor study centers. Although center hours vary, seven centers function nearly around the clock. Students find study centers useful; at institutions without centers (n=4), students often study in a classroom, a section of the residence hall or the library. These arrangements do not promote community building in the way that a study center does. Sixty-five percent of the MEP directors (n=13) cluster students for mathematics and science courses. Reasons for *clustering* include encouraging study groups, reducing ethnic isolation, and making tutorial services more readily available. MEP directors believe that clustering has a positive effect on students' academic performance. Students and faculty concur.

All institutions in the sample have active campus chapters of minority student engineering organizations such as the American Indian Science and Engineering Society (AISES), the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE) and the Society of Mexican American Engineers and Scientists (MAES). Local chapters generally reflect the organizations' national goals of providing a sense of community and support for minority engineering stu-

Table 5.
Community Building Activities

	Percent of Sample
Freshman Orientation Course	95
Provided by MEP	32
Provided by University	42
Provided by MEP/University	26
Study Center	85
For Individuals	6
For Groups	6
For Individuals/Groups	88
Clustering	65
Student Organizations	100

Figure 3.
MEP and University Recruitment Collaboration

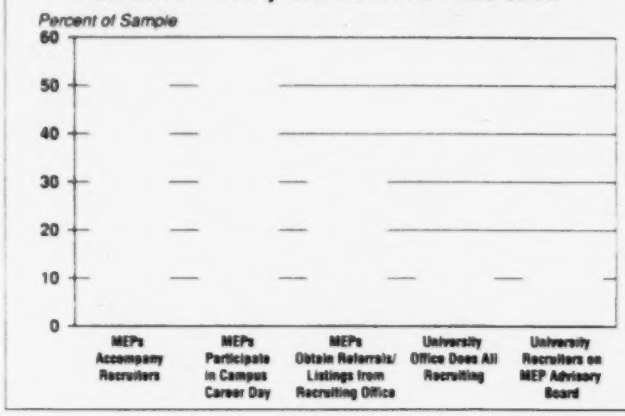


Figure 4
Transitional Services

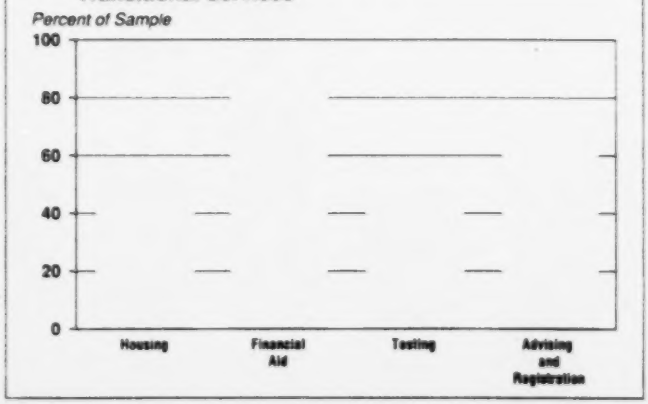


Figure 5.
Student Personal and Professional Development Functions

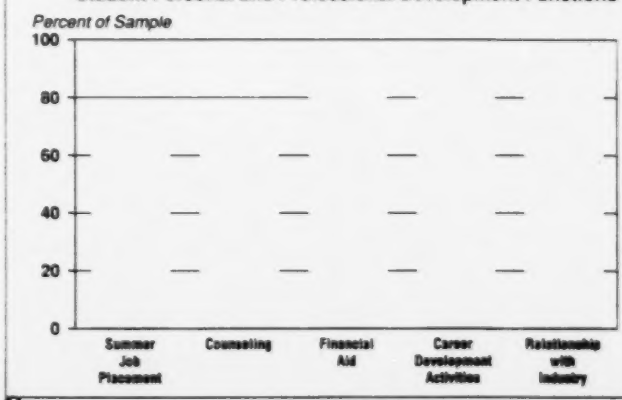


Table 6.
Academic Support Activities

	Percent of Sample
Structured Study Group	80
Academic Advising	90
Monitoring Student Progress	95
Tutorial Program	90

dents: increasing the number of minority engineers through recruitment, retention, and academic support; and easing the transition to employment. Activities include academic support services, community outreach activities, career development activities and social events. Most MEP students participate in these organizations unless constrained by work or study obligations. At most institutions (n=19) there is a working relationship between the student organization and the MEP that ranges from complementary programs to collaborative activities and services. According to students, the most beneficial aspects of these organizations are networking among students, developing a sense of community, making corporate contacts and developing leadership skills.

In addition to summer bridge programs and freshman orientation courses in the first year, MEPs offer ongoing *academic support* to buttress and reinforce students' skills. Table 6 indicates that most programs in the sample provide academic support through structured study groups, regular academic advising, monitoring student progress, and tutoring.

Structured study groups consist of an undergraduate or graduate student leader, who is trained in the discipline being studied, and students attending the same course. Only five of the 16 MEPs that provide structured study groups maintain data to assess the effectiveness of these groups, although two additional programs are beginning to collect assessment data. In every case, the programs that evaluate their study groups report that students who attend the groups perform better in those subjects than students who do not attend.

Most MEP students are assigned an *advisor*, usually an MEP staff member, with whom they meet at least once each term in the first two years. Juniors and seniors, who have departmental advisors, tend to meet less frequently with their advisors. Students at all levels found MEP advising efforts helpful in determining the appropriate course load and selecting effective teachers.

Ninety-five percent of the programs regularly *monitor student progress* by maintaining a computerized database containing test scores, course selections and grade point averages. MEPs review student transcripts and grades each term and solicit faculty comments. Students in academic difficulty are referred to services provided by either the MEP or the university. These services include tutorial sessions, personal counseling, and skills-building workshops on time management and study skills. While programs maintain complete data on current students, most lack a process for systematically collecting and analyzing longitudinal data on retention and graduation.

The majority of MEPs offer *tutoring* for a wide range of courses, especially the required core courses in math, science, and engineering. Tutorial services combine walk-in tutoring, offered at certain periods during the day, and sessions scheduled by appointment. Students at all academic levels use tutoring services and indicate that tutoring is helpful, and tutors are accessible when needed. Tutors are usually upper-division undergraduate honor students, or graduate students; only on rare occasions do faculty serve as tutors. Nearly half of the MEPs (n=9) use trained tutors and most programs (17 of 19) monitor tutorial services with varying frequency.

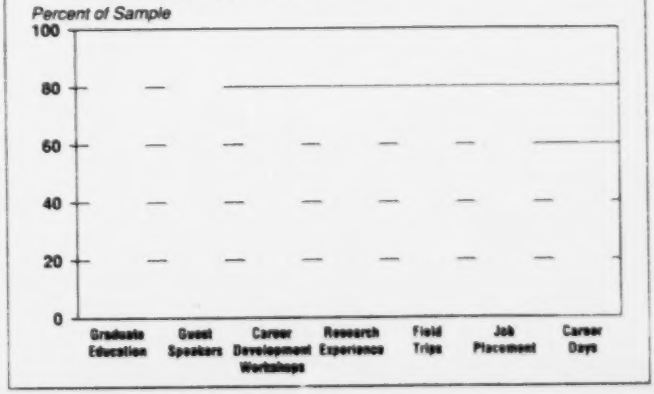
Students' *personal and professional development* is promoted through summer job placement, counseling, continuing financial aid advice, career development activities, and relationships with industry (Figure 5).

MEPs help students to find relevant *summer employment* in industry by making referrals and arranging job interviews. Students usually work for local companies, major corporations and government agencies. Occasionally, some have on- or off-campus research assignments. Most students express satisfaction with MEP job placement assistance.

Approximately 75 percent of MEPs provide academic and personal counseling to students. Slightly fewer have trained staff members. *Counseling* is provided primarily on an individual basis, with or without an appointment. Students with serious personal and social problems are referred to the university counseling center. Overall, students indicate that the counseling is helpful.

Students receive financial guidance at several points — prior to their entry into the freshman class and then again throughout their undergraduate career — reassessing need each year. Most

Figure 6.
Career Development Functions



MEP students receive *financial aid* in several of the available forms: scholarships, grants, student loans, and work-study. Programs tap into both university and external sources. In addition to providing financial assistance, most programs disseminate financial aid information and hold financial aid workshops in order to assist in the application process.

Professional development is enhanced through career days, internships and co-op experiences, resume writing and interviewing workshops, mentoring, research opportunities and seminars with corporate representatives. Seventy percent of the MEPs (n=14) provide career development workshops that invite company representatives and MEP graduates to make presentations on how to obtain a position in industry, what companies look for in employees, and what their own jobs entail. Several of the activities are joint efforts between the MEP and the minority student engineering organizations and several programs collaborate with the university placement office or career services center to sponsor career development workshops. Figure 6 presents the prevalence of selected career development functions.

Although 90 percent of the programs (n=18) promote graduate education, they use passive approaches such as providing printed information about graduate schools, advising students about the admissions process and describing fellowship opportunities. MEPs encourage students to become familiar with the university's graduate office and its services. Only a few MEPs take a more active approach, such as offering seminars by GEM (the National Consortium for Graduate Degrees for Minorities in Engineering and Science).

Seventeen programs (85 percent) report some *involvement with industry*. For example, 13 programs receive scholarships from companies, seek summer internships and include industry representatives on their advisory boards.

Institutional Environment

MEPs function within university environments and depend on institutional support. The degree to which the MEP is accorded legitimacy as part of the college of engineering, the manner in which the program is staffed, administered and housed, and the amount of influence it wields in the college of engineering and in the university as a whole are indicators of its perceived value. Specifically, institutional commitment is demonstrated by fiscal resources, staffing, office space, faculty involvement and reporting lines.

Most MEPs secure their *fiscal resources* from several sources, typically including university funds (those from the central administration or the college of engineering) and private funds (those from corporations, foundations or individuals). The most common type of MEP funding is a combination of university and private funds. A second popular scheme is single-source funding, where total support is received from either the university or corporations.

Three-quarters of the MEP directors (n=15) indicate that their funding, including that from the university, is inadequate. Most raise additional resources from industry and advocate making the salaries of the director and staff part of the university budget. Although directors accept fundraising activities as a crucial function of their position, nearly a third (n=6) indicate that fundraising takes too much time away from other duties. The level of assistance provided by the development office, either in the college of engineering or central administration, ranges from excellent to none.

MEP *staffing* typically includes a full-time director who reports to a tenured faculty member or to the dean of engineering. In addition, programs generally have at least one half-time clerical support position and utilize work-study students as office assistants, tutors, and recruiters. As programs grow and resources permit, additional staff members, such as recruiters or counselors, may be added.

Not surprisingly, most directors report that their programs run smoothly (70 percent) and that despite staff shortages, organization and administration are satisfactory (65 percent). MEP directors perceive their role as one of leadership and management. They cite supervision of program staff, fundraising, planning and development of programs, as well as participating in and overseeing daily activities, as their main functions. Generally, support staff feel they receive the administrative assistance they need to do their jobs effectively. Students report that staff, who are mostly minority group members, are both supportive and accessible.

At a minimum, engineering schools are expected to provide adequately furnished and equipped *office space* for the MEP, including a study center. Usually the MEP office is located near the Dean's suite, but some programs are housed in temporary buildings some distance from the college of engineering. The major problem reported, however, is lack of sufficient space rather than location.

MEP directors' *reporting lines* are either directly to the dean of engineering or to an associate or assistant dean (n=16). In some cases, supervisors exercise nominal oversight and, in others, there is involvement in the daily operation of the program.

Most faculty and deans stated that they highly regard the MEP and unanimously affirmed that the program benefitted the institution and students. Yet, while faculty members are involved in the program in a variety of peripheral roles, most directors (n=12) feel there is not enough *faculty involvement* in areas that affect students' long-term academic success (mentoring, research, advising).

Overall, levels of *institutional commitment* are ambiguous. Many MEP directors (n=16) and their supervisors (n=19) report that the institution has a long-term commitment to the program. Although this assertion was widespread, it is neither confirmed by the level of

funding nor by the degree of faculty involvement.

Summary of Success Factors

University-level support programs are not a new phenomenon. Early programs mostly provided tutorial services and administered financial support for students. MEPs differ from the more traditional, campus-wide programs in that they are based in a specific academic unit and therefore are able to leverage the fiscal, human and physical plant resources of the engineering school.[4]

Another critical difference lies in program focus. Most student support programs focus on staff-to-student interaction (e.g., tutors tutoring students, counselors counseling students, advisors advising students). In contrast, the MEP model is designed to be less costly while creating a high level of student-to-student interaction, attempting to leverage staff and program resources, and enhancing each student's experience on a daily basis. Clearly, some institutions are more successful at this than others.

Eight of the 20 sample institutions were identified as being the most successful in recruiting and graduating minority students. We found several types of activities that were unique to their MEPs (Table 7). In general, those engineering schools with the highest persistence and graduation rates for minority students support their MEPs with proportionately higher levels of funding, which ensure sufficient resources to address students' needs. These programs also attract more faculty involvement in teaching summer bridge classes. In addition, they focus on improving students' study habits, enhancing critical thinking skills and strengthening content knowledge.

Recruitment: MEPs at high-performing institutions tend to recruit students directly from high schools, generally bypassing the community college population. However, programs that do recruit from community colleges tend to participate in formal articulation agreements. This indicates the typically cautious approach employed by four-year colleges and universities when dealing with community college transfer students. Senior-level institutions often express concerns about the caliber and quality of course offerings at two-year colleges.

Admissions: Successful MEP institutions have no special or flexible policies for minority students not meeting standard admissions criteria. They do not attempt to close the admissions gap between minority and majority students by adjusting requirements; their efforts are focused more on attracting the best-qualified high school students.

Summer Bridge Programs: MEPs at the most effective institutions have summer programs that stress study and critical thinking skills over other activities. They also attract more faculty to teach these classes than do MEPs at less successful schools. Relatively little time is spent on general orientation during these summer programs, compared with MEPs in general whose summer bridge programs spend more time on basic orientation.

Community Building: The stated aim of "clustering" is to reduce ethnic isolation, which is seen as a barrier to superior academic performance. However, MEPs at successful institutions are more likely to provide study centers than to cluster students. Since these MEPs recruit students with stronger academic preparation, there is less perceived need to cluster their students to enhance academic performance. MEPs at successful institutions make less use of student organizations that are affiliated with national organizations for minority engineers. The community-building aspects of these organizations

Table 7
Identification of Success Factors

MEP Component	MEP Feature	Institutions Overall	Most Successful Institutions
Pre-enrollment Activities	Recruitment	High school outreach	Primarily high school outreach, little community college outreach
	Admissions	Special/flexible admissions policies for minority applicants	No special admissions policies
	Summer Bridge Program	Academic courses combined with orientation activities	Tend to combine course work with skills workshops and orientation activities
	Transitional Services	Academic advising for course registration and placement tests	
Matriculation Services	Community Building	Student organizations & freshman orientation courses	Provide study centers, less likely to cluster students
	Academic Support	Monitoring student progress, academic advising	More likely to have sufficient numbers of tutors available
	Student Personal & Professional Development	Career development activities	
Institutional Environment	Fiscal Resources	Funding from multiple sources	High level of university funding
	Staffing	Full-time directors, otherwise understaffed	Tend to have full-time directors, but they are less satisfied with the program
	Faculty Involvement	Marginal involvement	High perception that faculty is supportive but less satisfied with level of faculty involvement
	Reporting Lines	Report directly to engineering dean or assistant/associate dean	Less direct access to engineering dean

are provided as part of the overall operation of the MEPs.

Academic Support: MEPs at successful institutions tend to have sufficient numbers of tutors available and do not rely on their own monitoring for early detection of problems and identification of appropriate interventions. When problems are identified, these MEPs work closely with students to design and agree on appropriate intervention strategies.

Funding: MEPs at successful institutions have higher levels of university funding than other programs, ranging from 50 to 100 percent of the total budget, with the average being approximately 78 percent. By comparison, at the low end, university funding provided for the four MEPs in this group of schools averages approximately 32 percent of the budget. Most MEPs receive funds from multiple sources (e.g., corporations, foundations, the college of engineering, or the university).

Recommendations for Future Research and Program Development

The twenty-year history of MEPs has not resulted in an appreciable increase in the retention rate of minorities in engineering. Although enrollment figures have soared, the attrition gap remains.

This NACME study sought to identify the prevalence of predetermined components of the MEP model and link them to university retention. We found that, while most of the components occur across all programs studied, their presence could not be correlated justifiably with the retention levels of the schools in which they were located. We did find that many of these programs lack strong institutional support, have minimal faculty involvement and are viewed as peripheral to the mainstream of the engineering school. Thus, many institutions have failed to benefit fully from the potential impact of MEPs.

Our principal recommendations, therefore, largely target the institution rather than the MEP program itself.

1. Universities should institutionalize support for the MEP effort in their budgets, ensuring departmental commitment to the successful completion of degrees for minority engineering students.

Only four of the twenty schools examined had programs fully funded by their institutions. While colleges and universities have opened their doors to minorities in the last twenty years, they have not committed the resources needed to retain them. MEP programs must develop a stable funding base, possibly by mainstreaming program components into the overall activities of the host institution. University line-item funding for basic program necessities, such as staff salaries, would contribute to stability, but should be seen as only a step on the road to full institutional commitment. The present predominance of temporary funding from private sources threatens the stability and institutionalization of MEPs.

The institutional unit where the MEP is located helps to determine the effectiveness of the program. Ideally, the MEP should be located in the college of engineering and the immediate supervisor of the MEP director should either be the dean of engineering or have direct access to the dean.

2. Financial aid must be increased; the lack of financial resources is often a major obstacle to students' access to college. While not a direct responsibility of the MEP director, it is nonetheless a problem often found at the director's door. Ninety percent of the MEP directors studied report assisting on financial aid issues during the transition between high school and college, while 75 percent offer ongoing assistance during the undergraduate years.

In this study, scholarships were the most frequently mentioned and preferred form of financial aid. This is understandable given the enormous increase in the cost of higher education over the last ten years, coupled with the impact of recent financial aid policy changes on lower income students, many of whom are minorities. The past decade has seen an annual increase of 7.7 percent per year in public institutions, and 9.2 percent per year in private institutions for students who live on campus. Using a moderate projection, a public university minority student beginning engineering studies in 1996 and graduating four years later would pay between $40,000 and $56,000 for an education. A private university minority student during the same period could pay between $96,000 and $132,000.[7]

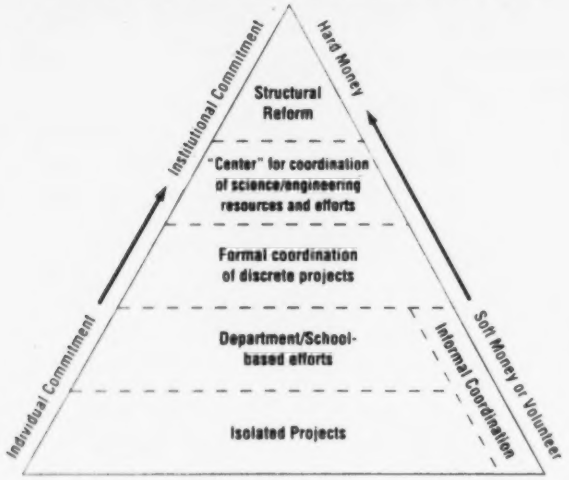
The composition of financial aid has changed dramatically as well, shifting from outright grants or scholarships to loans. In 1976-77, federal loans accounted for 22.6 percent of total aid. In 1991-92, this category jumped to 48.4 percent. There are a number of other policy changes that reallocate financial aid resources from poor to more affluent students. Clearly these trends negatively impact poor and minority students disproportionately, particularly as they affect students' needs to take on heavier work loads.

3. Increasing the number of minority engineering faculty is imperative. According to a report from the Department of Education, in the fall of 1987, African Americans and Hispanics comprised two percent of the engineering faculty; there were no American Indians recorded. Yet, given the paucity of doctorates being awarded each year, raising the total will take considerable time. In 1991, underrepresented minorities received only 100 Ph.D.s in engineering (African Americans 43, Hispanics 51, and American Indians 6) out of 2,782 total degrees awarded.[8]

The lack of a diverse faculty in the engineering classroom is neither insignificant nor without consequences. Minority faculty bring a cultural connection to their contact with students of color that can facilitate positive, ongoing interactions. In their absence, majority race faculty must be relied upon to mentor and advise minority

Figure 7

Model for the Evolution of Intervention Programs



Source: M.L. Matyas and S. Malcom (1991). *Investing in Human Potential*. American Association for the Advancement of Science. Washington, D.C.

students. Unfortunately, the typical engineering professor has minimal contact with most students, and is usually even more removed from minority students. As explained in *Retention by Design*,[9] for students of color this, coupled with low faculty expectations, contributes to poor academic performance. Furthermore, students often mimic the negative attitudes they see faculty display toward minority students, creating an overall climate of isolation. Having more minority faculty in the schools can minimize this behavior, as can training faculty to be more sensitive to race, gender, cross-cultural communications and other diversity issues.

4. Institutions must expand their commitment to diversity well beyond the establishment of MEPs. Colleges and universities must recognize the need to create faculty and student awareness of diversity issues throughout the institution. They must address the institutional impediments, create a more nurturing environment and promote a more satisfying academic experience for all students.

The components of the MEPs studied focus on personal change, on helping the student adjust to and accept the environment of the engineering school. Students are offered skills to improve their ability to negotiate the often hostile environment and to compensate for elements missing in the university culture. This places the burden squarely on the shoulders of the student to adjust to the prevailing culture.

Retention studies by Astin[10] and others confirm that the quality of faculty/student relationships is a decisive factor in students' decisions to drop out or persist in college. It is difficult to establish close relationships with busy faculty, and there are relatively few role models for minority students. Earlier NACME research indicates that the quality of faculty/student interaction significantly affects a student's perception of the college experience. Focusing on the university environment as a critical fac-

Another Model of the Evolution of Intervention Programs

As universities look to improve their retention programs, one model they can follow to assess their current level of commitment focuses on institutional support. The Matyas and Malcom study, published by the American Association for the Advancement of Science[5], describes a model (Figure 7) that has at its apex the institutional support of departments and programs, providing mechanisms to ensure the achievement of all students committed to education in science and engineering.

At the next lower rung (Level 4) institutions create centers for the coordination of large parts of the process of recruiting, training, tracking and advancing students to graduation. These centers form an organizational overlay to the mission of the institution, and are supported on hard money.

One rung down (Level 3) are formalized coordinated programs in one part of the institution, such as the college of engineering, where recruitment and retention of minority students is coordinated through the office of the dean. Funding for these programs includes external grants, but relies increasingly on hard dollars from the institution.

Level 2 shows individual schools or departments undertaking activities to address their own particular problems, such as high failure rates in calculus. These activities have little or no connection to the institution and address only a small part of the problems facing minority students.

The lowest level, Level 1, covers the commitment of individuals to address particular barriers to participation.

These efforts are isolated projects, and rely wholly on soft money and volunteer activity.

Nationwide, Level 1 is where most MEPs are found. The lack of a stable funding base undermines the scope and effectiveness of these intervention programs. Although some programs have secured permanent funding by mainstreaming their activities, most engineering programs still rely on external funding. Institutional funding would promote both departmental commitment and continued support of minority engineering students.

tor in student persistence, NACME has developed a series of diversity seminars that bring faculty and students together to explore issues of cross-cultural communication and increase awareness of and sensitivity to cultural diversity.

Many faculty members fail to provide meaningful support because they lack effective counseling skills. Some see the advising role as perfunctory and secondary to their main responsibilities, teaching and research. In addition, faculty members often are unaware of the existence and nature of cultural barriers, and of the relationship between their attitudes and how their message is perceived by students.

In the NACME model, a series of twelve faculty seminars centers on developing the specific behaviors that alleviate cross-cultural tension. Nine student workshops promote adjustment to an academic and cultural environment that may differ substantially from students' past experience. Students learn the "unwritten rules" of the engineering school environment.

5. Longitudinal studies are crucial. There is a great deal of information yet to be discovered about the links between student performance, MEP components, institutional climate, and retention. Monitoring the academic performance and progress of current MEP students is essential to retention. In the long term, however, it is essential to collect and analyze longitudinal data on program participants and dropouts in order to understand better the factors impeding students' academic progress and ultimate success in engineering.

While this study found that the theoretical model proposed for establishing an MEP does exist in practice, it is not clear what effect MEPs have on student performance measures. To assess the affects of program features on student achievement, longitudinal data should be collected at selected institutions with successful MEPs, following all freshman minority engineering students through graduation, with control groups of nonminority students.

A longitudinal study can help determine the extent to which students' entering characteristics (e.g. high school grades, SAT/ACT scores and socio-economic background) contribute to academic performance and would provide a database for the assessment of intervention strategies.

At the same time, the climate of the institution must be assessed. To date, the university culture itself has not been examined to the same extent as has the student experience. Present interventions do not focus on organizational responsibilities, which would address structure, environment, and behavior or beliefs of faculty. Under present practices at most engineering schools, expectations and standards for students' performance have been normed on majority male experiences and expectations. We need to reassess these expectations and recommend new institutional standards which are appropriate to all students, including minorities of both genders.

An understanding of the unique aspects of minority persistence and MEP effectiveness can only be gained from a comparative analysis of the experiences of nonminority students within the same institutions. This model would allow for the measurements of student achievement to be correlated with MEP program components, and with institutional commitments.

MEP directors will have to address both retention and the need for institutional commitment if they are to strengthen their programs; they must face both the need to define and help resolve retention problems unique to their institutions, which means understanding why some students withdraw and others stay the course. The fuller understanding of the factors in play will enable us to move closer to our goal of providing access and ultimate success for minority engineering students.

Acknowledgements

We wish to thank Beatriz Chu Clewell, who led the team from the Educational Testing Service that conducted the initial study. The ETS research team included Bernice T. Anderson, Molly F. Joy and Barbara Bruschi, with the assistance of Joyce Gant, Judy Pelham and Carla M. Cooper. In addition, our thanks to Wynetta Y. Lee at North Carolina State University and to Ismael Diaz and Frank Wells of NACME for helping to shape the final report. A very special thanks to the AT&T Foundation which provided funding for the project.

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